Bill Nye the Science Guy

# Momentum

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# Implementation Guide

***Welcome to Disney's Bill Nye DVD collection! With the help of this Guide you can bring instructional DVDs into your science curriculum.***

## What's on the DVD?

Bill Nye DVDs expand the educational features of *Bill Nye the Science Guy* programs. Each DVD provides students with science content through video clips aligned with *National Science Education Standards (NSES)* and a host of other resources.

Short video clips aligned with the NSES provide a unique opportunity for you to enhance your lessons using DVD technology. Now you can show a video clip, or even short segments of a clip, on command. But there are a host of other features, too! See the chart below for a summary.

### From the Main menu, there are three chief sections:

| Feature | Description |
|---|---|
| Watch Program Menu | From this menu, you can play the program straight through or use the clips to customize your viewing. |
| Teacher Support | From this menu, you can access this Teacher's Guide, the Glossary, Internet Links, and the Quiz. |
| Bonus Materials | Use this menu to try a different discussion starter, download a special screen-saver, or check out never-before-seen footage. |

### From the Watch Program menu, you can:

| Feature | Description |
|---|---|
| Play Program | Play the entire program from start to finish. |
| Bilingual Mode | View the entire program or clips in English or Spanish. |
| Glossary Mode | Make links to Glossary terms appear during the program. |
| Program Overview | View the program introduction, in which Bill discusses the topic covered. |
| Try This | Show students demonstrating science concepts. |
| Way Cool Scientist | Meet a real scientist who talks about his or her area of study. |
| Bill's Demonstration | Look at a science demonstration conducted by Bill Nye. |
| Music Video | Enjoy a short music video that summarizes the topic in an age-appropriate and entertaining manner. |
| Science Standards | Take advantage of short video clips from the program, which are aligned with National Science Education Standards. |

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### From the Teacher Support menu, you can:

| Feature | Description |
|---|---|
| Science Quiz | Give students a quiz to take independently or as a class. Seven to ten quiz items are aligned with the National Science Education Standards. The items are in multiple-choice or true-false format. Each wrong answer links to a standards-aligned video clip. At the end of the quiz, a scoring function reveals the number of correct initial answers. |
| Glossary | Check out definitions of key terms and view video clips that reinforce the concepts. |
| DVD Features | View a quick overview of the features found on the DVD. |
| Teacher's Guide | Print out or view this comprehensive Teacher's Guide in PDF format. |
| Internet Link | Link to the Bill Nye area of Disney's Edustation Web site, where you can find links to Internet sites related to the content of each Bill Nye program. |

### From the Bonus Materials menu, you can:

| Feature | Description |
|---|---|
| Bonus Material | Find out what *wasn't* in the episode! In most cases, there's more of the Way Cool Scientist interview, Bill Nye outtakes, and an extra discussion starter. |
| Additional Clips | See trailers of related DVDs and videos. |
| Screen-Saver | Download this cool screen-saver for your computer. |

## The Planning Process

This Guide provides a Lesson Planning Worksheet (see page 12), which can assist you in setting up your instruction around a topic. The following sections of this Implementation Guide are offered to assist your planning process:

- **Determining Objectives and Linking to Standards**
- **The Learning Cycle**
  - **Explore**
  - **Apply**
  - **Extend**
  - **Assess**

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## Determining Objectives and Linking to Standards

1. The NSES Teaching Standard A states that science teachers must "select science content and adapt and design curricula to meet the interest, knowledge, understanding, abilities, and experience of students."

   The NSES recommends that teachers "integrate . . . a practical structure for the sequence of activities, and the content to be learned." The primary instructional model recommended by the NSES is inquiry into authentic student-generated questions about natural or designed phenomena. Since most state and local standards documents were derived from the NSES, you will find that your local and state standards match closely with content standards in the Bill Nye DVD.

   Each DVD contains a menu of clips that are aligned with the NSES. You can review the standards and their aligned clips in the Science Standards menu under Watch Program. Also, the Standards listed on page 10 of this Guide allow you to look at additional NSES content standards that are addressed on the video. Here's an example of the content standards and clips aligned with the Bill Nye DVD entitled *Blood and Circulation*:

### Life Science Standards (NSES) Addressed in *Blood and Circulation*

**Life Science:**
**Structure and function in living systems**

- **Living systems at all levels of organization demonstrate the complementary nature of structure and function.**

  **Aligned clips:**

  - **1 Blood vessels**
  - **2 Heart pump and bloodstream**
  - **3 Heart valves and blood circulation**
  - **4 White blood cells**
  - **5 Capillaries**

- **The human organism has systems for digestion, respiration, reproduction, circulation, excretion, movement, control, and coordination, and for protection.**

  **Aligned clips:**

  - **6 Heart pump**
  - **7 Heart muscle**
  - **8 Pumping blood to brain**

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2. Determine your objectives for the lesson and how these objectives address the standards.

### Sample Objectives for *Blood and Circulation*

**In this activity students will:**

- **Observe and describe a body system responsible for supply and transport.**
- **Use this information to define a body system.**
- **Ask questions about the circulatory system.**
- **Explain how structure complements function in organs of the circulatory system.**
- **Cite examples of current research related to this system.**

3. Design a learning cycle of instructional experiences and assessments for the students to engage in that will help students meet these standards. Students may be given teacher-planned investigations or may be guided to design their own investigations.

## The Learning Cycle

The learning cycle is a sequence of activities that involve students in the learning process. The sequence found here is based on research from Lawson**,** Abraham, and Renner published in 1989. That has been adapted to include: Explore, Apply, Extend and Assess:

**Explore:** Involves assessing students' prior knowledge and providing opportunities for students to interact with content from the video.

**Apply:** Includes having students use the content learned during the Explore section in a new way that is meaningful to future learning.

**Extend:** Allows students to conduct further research around an area of interest within the topic.

**Assess:** Provides strategies meant to inform students and teachers about the content and processes that have been learned.

## Explore

The NSES Teaching Standard B states: "Teachers of science guide and facilitate learning." This standard addresses the constant need to balance your predetermined goals with allowing students to set and meet their own learning goals.

*Focus and Support Inquiries*: Support student inquiries by making decisions about "when to provide information" and "when to connect students with other sources." Knowing the best time to intervene is often determined by allowing students to ask questions and to explore concepts openly.

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The NSES Teaching Standard C states: "Teachers of science engage in ongoing assessment of their teaching and of student learning."

*Assess in Order to Guide Teaching:* The Program Overview or the Discussion Starter on the DVD can be used to gauge students' prior knowledge. You can use student responses to make decisions about appropriate instruction and adaptations in order to meet the needs of individual students. Assessment can be in the form of student reflections from standards-aligned video clips or answers to questions found on the science quiz. Or, as in the following example, a simple graphic organizer can facilitate a formative assessment.

### Example: T-Chart from *Blood and Circulation*

1. Ask students to fill out the "Know-New" T-Chart (see page 14). Have them list what they already know about the circulatory system (heart, blood vessels, blood, etc.) on the left side of their charts.

2. Show the Program Overview for *Blood and Circulation*. On the right side of the chart, have students list new things they have learned from watching the clip. Walk around the room and assist students in filling in their T-Charts. Replay the program as necessary to allow students to review sections of interest.

3. Once students have completed their charts, ask them to share what they have listed in the "New" column. Write these on the board. Have students write their own working definitions of the circulatory system. Once students have completed their definitions, collect and review their work to assess prior knowledge.

Conduct direct vocabulary instruction in the Explore phase. Research suggests that:

- Students must encounter words in context more than once to learn them.
- Instruction in new words enhances learning those words in context.
- One of the best ways to learn a new word is to associate an image with it.
- Direct vocabulary instruction on words that are critical to new content produces the most powerful learning.

Use the DVD Glossary with the linked video clips to expose students to new vocabulary words in context, along with associated video images. You can also find a printed version of the glossary terms in this Guide on page 16.

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### Example: Using the Glossary for Direct Vocabulary Instruction
### *Blood and Circulation*

1. Present students with a brief explanation or description of the new term or phrase from the glossary. For example: “Capillary: A small blood vessel that connects arteries and veins.”
2. Present students with a nonlinguistic representation of the new term or phrase. Show the video clip associated with the term “capillary.”
3. Ask students to generate their own verbal description of “capillary.”
4. Ask students to create their own nonlinguistic representation of “capillary.”
5. Periodically ask students to review the accuracy of their explanations and representations. This can be done after the Apply activities.

## Apply

Based on the information you gained from the Explore assessments, design appropriate activities for your students. Check the experiments listed in the Episode Guide (see page 11) for explanations of the demonstrations from the Bill Nye program as well as for additional experiments designed to help apply the knowledge gained.

In the following example from *Blood and Circulation*, the standards-based video clips provide background information, and an experiment from the Guide helps students apply what they have learned about arteries and veins.

### Example: The Structure and Function of Arteries and Veins

1. Have students begin “Know-New” T-Charts, focusing on what they already know about the structure and function of blood vessels, arteries, and veins.
2. Watch the following chapters from the Bill Nye DVD *Blood and Circulation*:
   - Blood vessels
   - Heart pump and bloodstream
   - Capillaries
3. Complete the “Know-New” T-Charts.
4. Give students copies of the Student Recording Sheet (see page 15) and have them fill the sheets out as they conduct their experiments.
5. Do the experiment entitled “Pump it Up!” from the *Blood and Circulation* Episode Guide, in which students observe the apparent effects of pressure on arteries and veins.
6. Write down any remaining questions about the structure and function of blood vessels, arteries, and veins.

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## Extend

The NSES Teaching Standard D states: "Teachers of science design and manage learning environments that provide students with the time, space, and resources needed for learning science." School administrators, parents, and the community can assist teachers in providing local resources that make science lessons pertinent and meaningful.

*Identify and Use Resources Outside of the School:* "The school science program must extend beyond the walls of the school." Each Bill Nye DVD contains resources designed to facilitate such understanding, including:

- Way Cool Scientist, found in both Watch Program and Bonus Materials, in which scientists discuss their current areas of study. This real-world connection often results in a deeper student understanding of a particular career.
- Disney's Edustation Web site, where relevant Internet links provide a starting point for students to further explore science topics.
- Try these video clips, with activities parents and students can do at home. The questions generated by students from these experiences can be used as foundations from which they may conduct their own research.
- Standards-aligned video clips and Bill's demonstration video clips, which can help generate topics for further research. After viewing the clips, have students list their questions, perhaps about the most current developments in a topic. By conducting online or library research, students will find answers to their questions and will learn about a topic in greater depth.

### Example: Conducting Student Research Using *Blood and Circulation*

Ask students to choose one of the questions they had after completing the activities from *Blood and Circulation*. An example of a student research question might be, "How has the technology related to artificial hearts advanced in the last ten years?" Explain to students that they will be conducting research to find answers to their questions. Some students may want to complete online or library research, others may want to ask an expert in the field, while others may want to design and conduct a scientific investigation. Encourage students to write a detailed procedure for finding answers to their questions. Ask students to find one or more examples of current research dealing with the circulatory system that is related to their question. NOTE: Students with similar questions may work together to complete the assignment.

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## Assess

Once students have conducted the research, you may choose to assess them in a number of different ways:

- By having students write about what they learned in a journal.
- By having students submit projects or reports.
- By having students take the program quiz to gauge their understanding of certain facts in the video. You can either print the quiz (found in this Guide on page 18) and have each student complete it individually or use the DVD screen version and the scoring feature for whole-class assessment.
- By designing other standards-aligned questions to augment those that are provided.

While the quiz will provide you with information about what the students have learned, it does not assess how students have processed the information. Below you will find assessment ideas that can be used to measure both content and process.

### A Sample Assessment for *Blood and Circulation*

1. Explain to students that an important aspect of scientific inquiry is to communicate findings to others. In this assessment, students will present the following information to their peers:
   - The question they investigated.
   - The method that was used to find answers to their question.
   - Problems or successes during the search.
   - Answers to their question.
   - Current research related to their question.
   - New questions that have arisen.
2. Distribute the rubric found in the Lesson Planning Worksheet (see page 13) to students so they know how they will be assessed. Make sure students understand the criteria found in the rubric. Before you begin, you may want to allow students to make changes to the rubric so that it is clearer or makes more sense from their perspectives.
3. Allow students time to gather information to answer their questions and to prepare for their presentations. As students conduct this work, walk around the room and ask questions to assess their progress and provide input as needed.
4. Take a few minutes to clarify the rules of the presentation with the students. You may want to have multiple copies of the rubric available so that peers can rate the presentations.
5. As presentations are made, assess the quality of the student's work as thoroughly and as equitably as you possibly can.

Congratulations! You have now completed the steps to set up a lesson plan using the Lesson Planning Worksheet. You have also explored many of the features of the Bill Nye DVD as well as the supplemental information found in this Teacher's Guide. And most important, you've made significant strides toward incorporating DVD technology into your day-to-day instruction.

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# National Science Education Standards

## *Momentum*

### *Standards/Benchmarks – Grades 5-8*

## Science as Inquiry

### Abilities necessary to do scientific inquiry

- Identify questions that can be answered through scientific investigations.
- Design and conduct a scientific investigation.
- Use appropriate tools and techniques to gather, analyze, and interpret data.
- Develop descriptions, explanations, predictions, and models using evidence.
- Communicate scientific procedures and explanations.

### Understandings about scientific inquiry

- Different kinds of questions suggest different kinds of scientific investigations. Some investigations involve observing and describing objects, organisms, or events; some involve collecting specimens; some involve experiments; some involve seeking more information; some involve discovery of new objects and phenomena; and some involve making models.
- Technology used to gather data enhances accuracy and allows scientists to analyze and quantify results of investigations.
- Scientific explanations emphasize evidence, have logically consistent arguments, and use scientific principles, models, and theories. The scientific community accepts and uses such explanations until displaced by better scientific ones. When such displacement occurs, science advances.

## Physical Science

### Motions and forces

- The motion of an object can be described by its position, direction of motion, and speed. That motion can be measured and represented on a graph.
- An object that is not being subjected to a force will continue to move at a constant speed and in a straight line.
- If more than one force acts on an object along a straight line, then the forces will reinforce or cancel one another, depending on their direction and magnitude. Unbalanced forces will cause changes in the speed or direction of an object's motion.

### Transfer of energy

- Energy is a property of many substances and is associated with heat, light, electricity, mechanical motion, sound, nuclei, and the nature of a chemical. Energy is transferred in many ways.

## Science and Technology

### Abilities of technological design

- Implement a proposed design.
- Evaluate completed technological designs or products.
- Communicate the process of technological design.

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### Understandings about science and technology

- Scientific inquiry and technological design have similarities and differences. Scientists propose explanations for questions about the natural world, and engineers propose solutions relating to human problems, needs, and aspirations. Technological solutions are temporary; technologies exist within nature and so they cannot contravene physical or biological principles; technological solutions have side effects; and technologies cost, carry risks, and provide benefits.

- Perfectly designed solutions do not exist. All technological solutions have trade-offs, such as safety, cost, efficiency, and appearance. Engineers often build in back-up systems to provide safety. Risk is part of living in a highly technological world. Reducing risk often results in new technology.

- Technological designs have constraints. Some constraints are unavoidable, for example, properties of materials, or effects of weather and friction; other constraints limit choices in the design, for example, environmental protection, human safety, and aesthetics.

## Science in Personal and Social Perspectives

### Personal health

- The potential for accidents and the existence of hazards imposes the need for injury prevention. Safe living involves the development and use of safety precautions and the recognition of risk in personal decisions. Injury prevention has personal and social dimensions.

### Science and technology in society

- Societal challenges often inspire questions for scientific research, and social priorities often influence research priorities through the availability of funding for research.

- Technology influences society through its products and processes. Technology influences the quality of life and the ways people act and interact. Technological changes are often accompanied by social, political, and economic changes that can be beneficial or detrimental to individuals and to society. Social needs, attitudes, and values influence the direction of technological development.

- Scientists and engineers work in many different settings, including colleges and universities, businesses and industries, specific research institutes, and government agencies.

- Science cannot answer all questions and technology cannot solve all human problems or meet all human needs. Students should understand the difference between scientific and other questions. They should appreciate what science and technology can reasonably contribute to society and what they cannot do. For example, new technologies often will decrease some risks and increase others.

## History and Nature of Science

### Nature of science

- Scientists formulate and test their explanations of nature using observation, experiments, and theoretical and mathematical models. Although all scientific ideas are tentative and subject to change and improvement in principle, for most major ideas in science, there is much experimental and observational confirmation. Those ideas are not likely to change greatly in the future. Scientists do and have changed their ideas about nature when they encounter new experimental evidence that does not match their existing explanations.

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# Episode Guide

## *Momentum*

| Nifty Questions in This Episode | Awesome Answers |
|---|---|
| What is momentum? | Momentum is the product of moving things: speed times mass equals momentum. |
| Is there momentum in a moving rocket? | Yes. The momentum of hot fuel pushing out the back of the rocket equals the momentum of the rocket going forward. |
| Is velocity related to momentum? | Yes. The faster you push (momentum) an object (mass), the farther and faster (velocity) the object travels. Velocity is the speed and the direction of a moving object. |

## Experiments shown on the video:

### FOOT-LONG QUARTER

***Objective: To demonstrate action and reaction by showing that vibrations are carried along solid objects.***

- Place a ruler on a table top.
- Place a dime on the table touching one end of the ruler and a quarter at the opposite end.
- Using the quarter, slide and hit the end of the ruler.
- What happens to the dime? Measure the distance the dime traveled.
- Repeat the procedure, using the dime to hit the ruler while the quarter touches other end. Report your findings.

### STRETCH!

***Objective: To demonstrate that air escaping from a balloon can move the balloon along a string.***

- Work with a partner.
- Thread a string through a drinking straw and tape the string between two walls.
- Blow up a long, skinny balloon.
- While holding the end of the balloon, tape the body of the inflated balloon to the straw.
- Release the balloon; observe.

## More interesting stuff to do:

### QUICK AS A WINK

***Objective: To demonstrate that less friction allows objects at rest to remain at rest.***

- Lay a playing card flat on top of a glass.
- Place a coin on the center of the card.
- Pull the card out quickly from under the coin; be careful to pull the card toward you and keep it parallel to the table top.
- Try flicking the card away with your finger.
- In both cases, the penny should fall into glass.
- What would happen if the card had a rubber or sandpaper surface? Try it.

### SLIP AND SLIDE

***Objective: To demonstrate momentum and friction.***

- Stack eleven smooth-edged, black checkers on a table.
- Insert a red checker on top of the bottom black checker; straighten the stack.
- Stand another black checker on end about 5 inches away from the stack (lined up with the midpoint of the stack).
- Flick or squirt the standing black checker with your fingers, forcing the checker to hit the red checker in the stack.
- The red checker will sail out, and the remaining black checkers will fall straight down onto the bottom checker.
- Repeat the procedure, but try placing the red checker on the bottom of the stack.
- Vary the experiment by hitting the red checker in the stack with a ruler.

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# Lesson Planning Worksheet

**Lesson Title** _____

**Objectives** _____

_____

_____

**Estimated Time Required** _____

**Materials Needed** _____

_____

**National Science Educational Standards**

_____

_____

_____

_____

_____

**Explore** _____

_____

_____

_____

**Apply** _____

_____

_____

_____

**Extend** _____

_____

_____

_____

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## Assess

As presentations are made, assess the quality of the student's work as thoroughly and as equitably as you possibly can. The following criteria can be used to assist in your assessment.

Name of Student _____

Question Investigated _____

| Initial Question | | | |
|---|---|---|---|
| 1<br>Question is broad and not well defined | 2<br>Question is defined but limited to single-answer responses. | 3<br>Question is clear and might elicit multiple responses that may lead to new ideas and additional questions. | 4<br>Question is engaging and provokes new ways of thinking about an issue. |
| **Methods for Finding Answers** | | | |
| 1<br>Students do not share planned or actual methods. | 2<br>Students share methods but they are unclear or vague. | 3<br>Students share methods but not the problems or successes of using the methods. | 4<br>Students share methods and problems or successes in using the methods. |
| **Results** | | | |
| 1<br>Student results are undefined. | 2<br>Student results are incomplete and do not adequately answer the question. | 3<br>Student results are complete, adequately answer the question, and include current research related to the question. | 4<br>Student results are complete, include current research, and have resulted in one or more additional questions. |
| **Communication** | | | |
| 1<br>Student is not prepared to speak. | 2<br>Presenter has distracting mannerisms and avoids eye contact with the audience. | 3<br>Presentation is clean and clear with some eye contact and very few distractions. | 4<br>Presentation is exceptional and unique. Presenter uses regular eye contact and avoids distractions. |

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# Student "Know / New" Chart

| Know | New |
| --- | --- |
| Write down what you know about the topic of the video. | Write down information from the video that is new to you. |
| | |

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# Student Recording Sheet

Name _____ Date _____

Title of Experiment _____

Question: (What are you testing?) _____

Procedure: (Describe the experiment) _____

Materials: (List what you used) _____

Observations: (Record what happened) _____

Results: (Make your own data table)

Conclusions: (Use your observations and results to describe what you learned)

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# Glossary

## *Momentum*

Fold and cut to use as flashcards.

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**MOMENTUM**

**Momentum**

A property of any moving object. The momentum of a particular object is equal to its mass times its velocity. A massive object going at a high velocity has a large momentum.

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**MASS**

**Mass**

A measure of the total amount of material in a body. Physicists define it as a measure of a body's resistance to acceleration. Mass shouldn't be confused with weight, which is a measure of the force of gravity on an object.

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**CONSERVATION OF MOMENTUM**

**Conservation of Momentum**

A fundamental law of physics that states that the momentum of a system does not change as long as there are no outside forces acting on the system.

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**VELOCITY**

**Velocity**

A measurement indicating both the speed and direction of a moving object.

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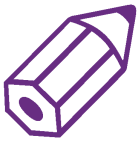
Name _____ Date _____

# Quiz

## *Momentum*



## True or False? Circle T or F

1. The momentum of objects depends upon how much volume they occupy. T or F
2. Momentum is the property of stationary (or non-moving) objects. T or F
3. Momentum is energy that can be transferred to other objects. T or F
4. In a collision, the faster an object is moving and the more mass it has, the more momentum is transferred to the object it collides with. T or F
5. The momentum of a rocket's forward motion equals the momentum of the fuel pushing out the back. T or F
6. When a ball bounces, its momentum is transferred to the ground. T or F
7. Momentum can be transferred through a stationary (or non-moving) object. T or F

## Multiple Choice: Circle the letter of the best answer

8. Which of the following statements is true concerning transferred momentum?
   - A. Energy transferred to an object moves a heavy object farther than a lighter object.
   - B. Energy transferred to an object moves a lighter object farther than a heavy object.
   - C. Energy transferred to an object moves a heavy object the same distance as a lighter object.
   - D. None of the above.

9. Which of the following statements best describes what happens when a ball, which has been cooled in liquid nitrogen, hits the ground?
   - A. It bounces.
   - B. It stops bouncing.
   - C. It shatters and loses all its momentum.
   - D. It shatters and the momentum of all the pieces equals the momentum of the bouncing ball.

10. Which of the following is true regarding a moving car and its driver?
    - A. Both the car and driver have momentum in a moving car.
    - B. If the car stops, the driver will keep moving.
    - C. If the car stops, the driver's seat belt will stop him/her from moving.
    - D. All of the above.

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# Answer Key

## *Momentum*

| | | | |
|---|---|---|---|
| 1. F | 4. T | 7. T | 9. D |
| 2. F | 5. T | 8. B | 10. D |
| 3. T | 6. F | | |

MOMENTUM

VELOCITY

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